PROJECT ADMINISTRATION DATA SHEET

[x] ORIGINAL [ ] REVISION NO. _____

roject No. A-3262 DATE 6/4/82

roject Director: ~~Berry O. Pyron~~ Dr. E.J. Scheiber School/Lab STL

ponsor: Teledyne Brown Engineering; Huntsville, AL

ype Agreement: Contract No. SC-6802 under Prime #DAAH01-81-C-A899

ward Period: From 5/25/82 To 4/1/83 (Performance) 4/27/83 (Reports)

ponsor Amount: $110,317 Contracted through:

ost Sharing: N/A GTRI/~~GIT~~

itle: T E L Refurbishment

DMINISTRATIVE DATA

OCA Contact Leamon R. Scott

) Sponsor Technical Contact:

Roger Watson
Teledyne Brown Engineering
300 Sparkman Dr.
Huntsville, AL 35807

2) Sponsor Admin/Contractual Matters:

Don Blaise
Subcontract Administrator
Teledyne Brown Engr.
300 Sparkman Dr.
Huntsville, AL 35807

efense Priority Rating: DO-A2

Security Classification: *

ESTRICTIONS

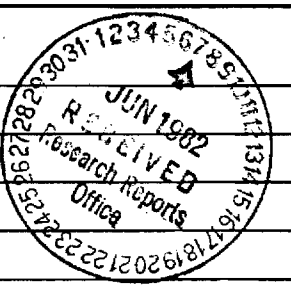
ee Attached government Supplemental Information Sheet for Additional Requirements.

ravel: Foreign travel must have prior approval – Contact OCA in each case. Domestic travel requires sponsor approval where total will exceed greater of $500 or 125% of approved proposal budget category.

quipment: Title vests with none proposed

OMMENTS:

* DD254 to be forwarded under separate cover.



OPIES TO:

Administrative Coordinator
Research Property Management
Accounting
Procurement/EES Supply Services
Research Security Services
Reports Coordinator (OCA) ✓
Legal Services (OCA)
Library
EES Public Relations (2)
Computer Input
Project File
Other GTRI

ORM OCA 4:781

GEORGIA INSTITUTE OF TECHNOLOGY OFFICE OF CONTRACT ADMINISTRATION

SPONSORED PROJECT TERMINATION SHEET

Date 2/14/83

Project Title: TEL Refurbishment

Project No: A-3262

Project Director: Dr. E. J. Scheibner

Sponsor: Teledyne Brown Engineering

Effective Termination Date: 4/1/83

Clearance of Accounting Charges: 4/27/83

Grant/Contract Closeout Actions Remaining:

- [x] Final Invoice and Closing Documents
- [ ] Final Fiscal Report
- [ ] Final Report of Inventions
- [ ] Govt. Property Inventory & Related Certificate
- [ ] Classified Material Certificate
- [ ] Other _____

Assigned to: STL (School/Laboratory)

COPIES TO:

Administrative Coordinator	Research Security Services	EES Public Relations (2)
Research Property Management	Reports Coordinator (OCA)	Computer Input
Accounting	Legal Services (OCA)	Project File
Procurement/EES Supply Services	Library	Other PA

+-3262

Georgia Institute of Technology
ENGINEERING EXPERIMENT STATION
ATLANTA, GEORGIA 30332

29 September 1982

Teledyne Brown Engineering Company
Cummings Research Park
300 Sparkman Drive
Huntsville, AL 35807

Attention: Mr. Roger Watson
Subcontract Monitor

Reference: Subcontract SC-6802
Monthly Status Report No. 1

Dear Mr. Watson:

The designated task under Subcontract SC-6802 is primarily the refurbishment of the Land Navigation Equipment. The planned activities under the task are outlined in the attached Schedule of Work. The contract with Georgia Tech was initiated on 25 May 1982 and approval of the task was received from Teledyne Brown Engineering Company on 8 September 1982. This letter summarizes the activities under the contract for the month of September 1982.

On 15-17 September, Dr. E. J. Scheibner, Dr. B. R. Livesay, and Mr. Bobby J. Wilson visited TBE and Redstone Arsenal to pick up the equipment and documentation and to discuss the task. They conferred with Mr. Thackray, Mr. George Sibble, and Mr. Bruce McIntyre of TBE and Mr. Jerry Langford and staff members of the Inertial Systems Development Branch at Redstone.

It was agreed to change the due date for the draft acceptance test plan from 1 October to 1 November 1982. The acceptance test will be performed by TBE in March 1983 but a system test is proposed for mid-December at Georgia Tech. It is expected that informal technical reviews will be held during the project, although no formal requirement is included in the contract.

A request has been made to schedule gyro tests at Redstone during the week of 11 October or the week of 18 October. These tests will involve drift measurements under different conditions. At a later date we anticipate the need for random vibration tests on the same gyro, also at Redstone.

Activities during September were focused upon system and component inspection preparatory to system power-up, the development of detailed plans for the gyro investigations, and the fabrication of test cabling and connectors. Additional data on the four types of microcircuits have been obtained from Mr. Larry Cummings of the Avionics Lab at WPAFB which are being reviewed along with other data to obtain a better characterization of each type. It would be highly desirable to obtain some of these microcircuits for destructive analysis. Current plans are to ascertain whether the microcircuits are monolithic or hybrid before replacement designs are considered. The other activities planned for next month include the system power-up and checkout, the gyro tests at Redstone and the assembly of test instrumentation for checking out individual components.

Very truly yours,

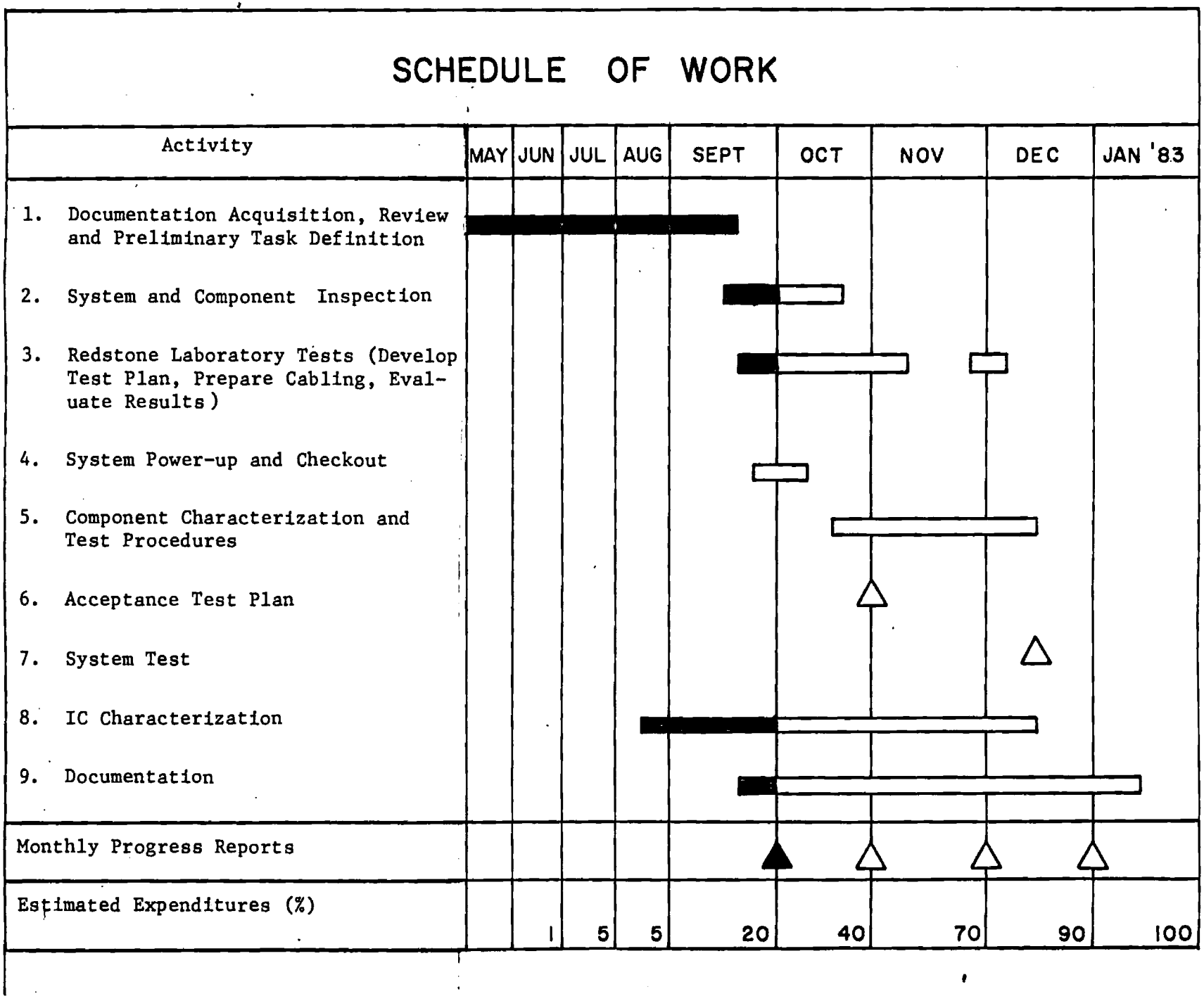
Berry O. Pyron
Project Director

BOP:ger

CC: R. Thackray

NOTE: Expenditures through the month of August were $5,210.34. Figures for September will not be available until the middle of October.

SCHEDULE OF WORK



PLANNED ACTIVITIES

1. This activity covered the period prior to the designation of a specific task and involved the review of existing documents related to the entire equipment item at TBE and the definition of the task on the navigation equipment.

2. System and Component Inspection
   - o Inspection of equipment at TBE
   - o Partial disassembly at Georgia Tech and physical inspection
   - o Design and assembly of special test fixtures
   - o Assemble test instrumentation

3. Redstone Laboratory Tests
   - o Develop test plan
   - o Prepare test cabling
   - o Gyro drift measurements utilizing Leitz division head, Scorsby table and environmental chamber (for test to $+70^{\circ}$ C)
   - o Comparison of results with previous data
   - o Random vibration test of gyro

4. System Power-up and checkout
   - o Interconnection of components with cabling from vehicle
   - o Operational test to verify performance or to detect and isolate malfunctions
   - o Troubleshooting and repair as necessary

5. Component Characterization and Test Procedures
   - o Disassemble and characterize each component by comparison with information in previous documentation
   - o Identify critical parts for which replacements should be provided
   - o Develop test procedures for each component and prepare recommended procedures for depot level maintenance including instrumentation requirements

6. Acceptance Test Plan
   - o Prepare acceptance test plan and submit draft copy for approval

7. System Test
   - o Conduct system test at Georgia Tech in accordance with the approved acceptance test plan

8. IC Characterization
   - o Collect and review available information on four IC types
   - o Determine the availability of direct US replacements
   - o Design of alternative replacements if no direct replacements are available, identify potential manufacturers, and obtain estimated costs per item (prior approval by TBE required)
   - o Procure prototypes for each type, verify specifications and develop acceptance test plan for manufactured items (prior approval by TBE required)

9. Documentation
   - o Photography including, for example, documentation of disassembly procedures, and printed circuit board photos for comparison with information in previous documentation
   - o Drafting requirements for schematics, diagrams, etc. including disassembly drawing for gyro
   - o Test procedures documentation
   - o Specifications for special test fixtures, etc.

Georgia Institute of Technology
ENGINEERING EXPERIMENT STATION
ATLANTA, GEORGIA 30332

29 October 1982

Teledyne-Brown Engineering Company
Cummings Research Park
300 Sparkman Drive
Huntsville, Al. 35807

Attention: Mr. Roger Watson
Subcontract Technical Monitor

Reference: Subcontract SC-6802
Monthly Status Report No. 2

Dear Mr. Watson:

The designated task under Subcontract SC-6802 is primarily the refurbishment and testing of the Land Navigation Equipment. Significant progress on several of the planned activities was made during the past month. The percent completed for each activity is indicated on the attached schedule of work and further details are discussed herein.

The system and component inspection (Activity 2) and the system power-up and checkout (Activity 4) were completed. The system was inoperable when received and the fuse in the coordinate computer was blown. The following repairs were made:

a. Resolder connection in cabling. It is recommended that all connections in the system cabling be cleaned and resoldered before reinstallation in the vehicle to provide improved reliability.

b. A 33 μ fd 20 V capacitor in the input filter network of the coordinate computer was shorted. This was replaced with an equivalent capacitor. It is recommended that all capacitors (C9-C12) in the filter network be replaced because of the marginal voltage rating.

The following observations of the condition of the equipment should be noted:

a. Rotating the shaft of the path sensor reveals a slight binding in the mechanical structure which may be due to gear misalignment or bearing wear. This problem will be identified and corrected.

b. From gyro drift measurements at Georgia Tech and at Redstone and from internal visual examination, it is apparent that problems exist due to insufficient lubrication of the gimbal roller bearings. The gyro will be cleaned with Freon and relubricated with Dow Corning

DC-200. The static balancing of the gyro rotor will also be accomplished prior to repeating the drift measurements. The gyro gimbal assembly will be removed and replacement roller bearings identified.

c. The rubber switch covers on the coordinate computer need to be replaced. It is recommended that TBE obtain a supply of these.

d. Indicator needles required straightening.

e. The speedometer drive unit exhibits excessive wear and insulator damage. Since this item is not part of the navigation system for which we are responsible, it is recommended that TBE obtain a replacement unit, perhaps replacing it and the speedometer with US equivalent items.

Gyro drift tests were conducted at Redstone, October 18-20 by B. R. Livesay, E. J. Scheibner, and B. J. Wilson of Georgia Tech with the assistance of Aubrey Rogers, Arthur Shell and Newman Oldham of the Inertial Systems Laboratory. These tests consisted of drift measurements as a function of the random drift setting on the drift control unit with the gyro mounted on a Leitz division head (static-level and tilted) and with the gyro mounted on a Scorsby table (dynamic-max run tilt angle of 15 degrees). On October 19, we discussed test procedures with Ed Blake of TBE's test bench design group and Nolen Poarch of TBE's systems engineering group. Both plan to visit us at Georgia Tech on November 4-5. On October 20, we reviewed our technical progress with Mr. Roger Watson, Bob Thackray and Bruce McIntyre of TBE.

A request has been made to obtain on loan until December 15 three items from the Inertial Systems Laboratory: the Leitz division head, a small Scorsby table and a similar gyro. These items will enable further gyro testing and the necessary alignment procedures.

Special instrumentation has been assembled to test or operate separate components of the navigation equipment. For example, a drive motor, controller and gear reduction unit attached to the path sensor enables the simulation of vehicle motion. The generation of pulses with a simple digital circuit and the simulation of analog signals from the gyro's resolver enable testing of the coordinate computer independent of the other components in the system. A special test connection has been made for the computer and AC/DC voltages and frequency are monitored routinely.

The draft acceptance test plan, due on 1 November, will be delayed a few days in order to establish the correct data for gyro drift.

The characterization of the four types of ICs has essentially been completed and a preliminary microcircuit data package is included for your review. Available literature was used to determine the

electrical functions of the different types and radiographic techniques were used to identify the method of manufacture of the microcircuits. As a result of this analysis, it was found that these circuits were produced by hybrid techniques. The X-ray photographs clearly show the internal interconnect pattern as well as the discrete components within the package. No domestic equivalent circuits in integrated or hybrid form were found after an extensive search. It appears to be feasible to obtain replacement hybrids and discussions were initiated with Bob Suloff and Bob McMillian of Insouth, Inc., a hybrid manufacturer in Auburn, Alabama. A proposal for proceeding in this direction has been forwarded to Mr. George Sibble of TBE through our contracting office and we would appreciate prompt action on this proposed modification of the existing subcontract.

During the next period, emphasis will be placed on the cleaning, lubrication and alignment of the directional gyro and the development of test instrumentation and procedures for the coordinate computer.

Very truly yours,

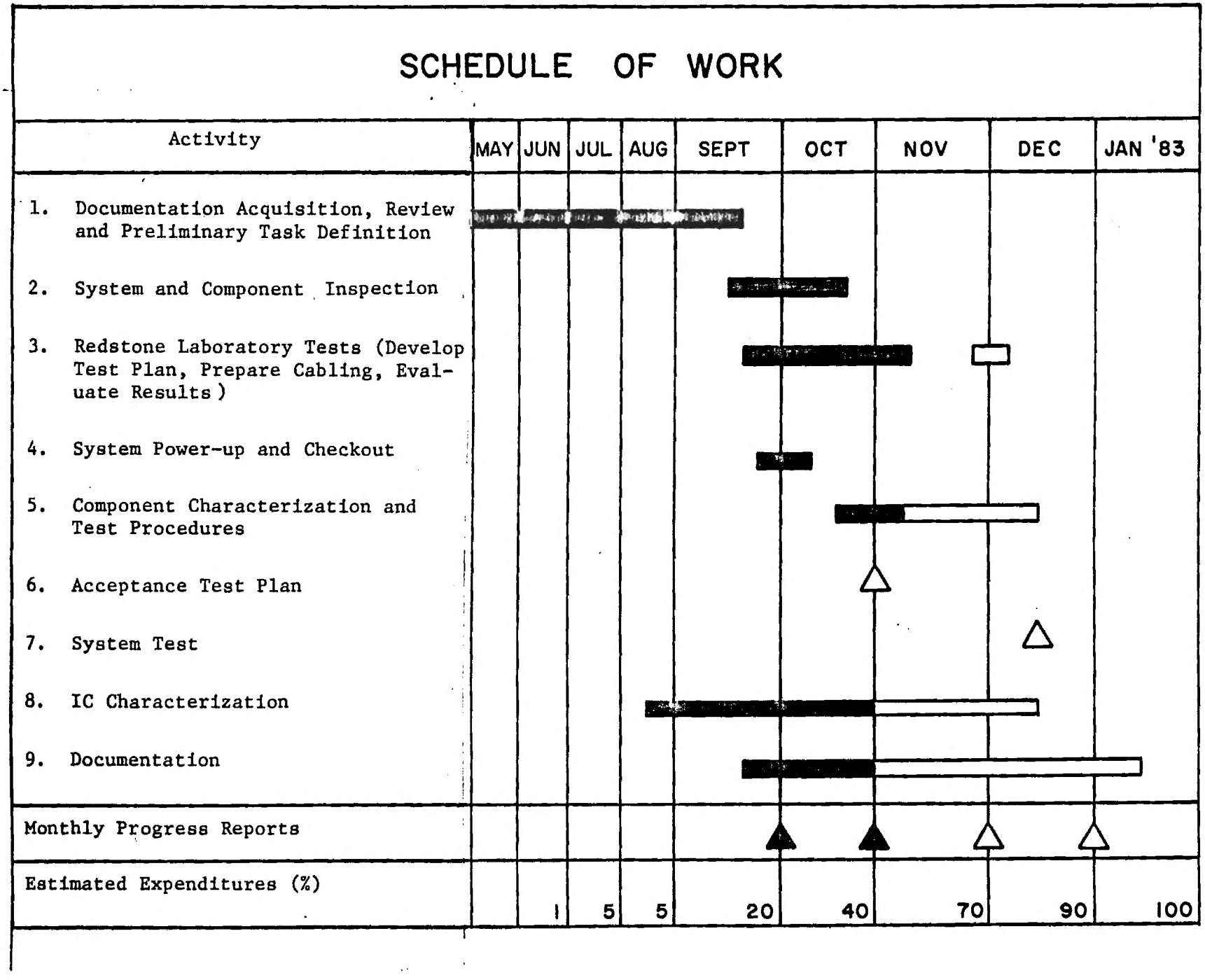
Edwin J. Scheibner
Project Director

EJS:ger

CC: R. Thackray

NOTE: Expenditures through the month of September were $20,780. Figures for October will not be available until the middle of November.

SCHEDULE OF WORK



Georgia Institute of Technology
ENGINEERING EXPERIMENT STATION
ATLANTA, GEORGIA 30332

30 November 1982

Teledyne-Brown Engineering Company
Cummings Research Park
300 Sparkman Drive
Huntsville, Al. 35807

Attention: Mr. Roger Watson
Subcontract Technical Monitor

Reference: Subcontract SC-6802
Monthly Status Report No. 3

Dear Mr. Watson:

The designated task under Subcontract SC-6802 is primarily the refurbishment and testing of the Land Navigation Equipment. Major accomplishments during the past month were the disassembly of the gyro and the development of detailed cleaning and lubrication procedures. The percent completed for each activity in the program is indicated on the attached schedule of work and further details are discussed herein.

On November 4-5, Ed Blake of TBE's Test Bench Design Group and Nolen Porsch of TBE's Systems Engineering Group visited Georgia Tech to discuss test bench requirements and system testing and to observe the operation of the system. A suggestion was made that we participate in the test bench design for the navigation equipment. Such an arrangement would be acceptable to us. It is our understanding, however, that this task would be outside the scope of the present subcontract.

On November 11, Roger Watson, Bob Thackray, and Bruce McIntyre of TBE visited Georgia Tech for the purpose of being briefed on the current status of the project. Discussions were held with E. J. Scheibner, B. R. Livesay, B. J. Wilson and Mike Harris. As a result of these discussions it was agreed that Mike Harris would submit a revised proposal for modification of SC-6802 to include an extension of the integrated circuit task through the fabrication and testing of prototype replacement microcircuits. The original request for modification of SC-6802 was dated October 26, 1982, and the revised modification was submitted on November 16, 1982.

In addition it was requested that a separate cost estimate be prepared for a training session of approximately one week for five students, to be held at Georgia Tech the week of December 13. This proposal for modification to SC-6802 was submitted on November 19, 1982.

At the request of George Provamcha of TBE, Mike Harris presented, on November 23, his studies of the microcircuits in the system to Mr. Provamcha and two students, as an example of reverse engineering. The presentations included both lectures and laboratory demonstrations.

A further item discussed at the November 11th meeting was the need for a replacement rotor for the gyro. B. R. Livesay agreed to obtain critical measurements on the rotor and to request information on possible replacements from a gyro manufacturer. A draft of the acceptance test plan was also provided at the meeting.

The development of special test instrumentation for testing the coordinate computer is approximately 90% complete. This instrumentation includes a simulator for the odometer which can be programmed for distance travelled, direction and vehicle speed, and a gyro simulator which provides typical fine and coarse resolver output voltages. A minor addition to the odometer simulator enables the unit to be used to drive a stepping motor attached to the odometer shaft. This arrangement would replace the motor, motor controller and gear box setup presently being used.

Measurements have been made of the input and output waveforms on each of the PC boards in the coordinate computer and a revised system block diagram has been developed. With this information one could isolate malfunctions to the board level. We recommend this procedure for the host country and the replacement of complete boards as a first step in equipment repair. Testing and repair of individual boards could be accomplished subsequently.

The mechanical section of the gyro was disassembled down to the rotor which has a hermetically-sealed housing. Measurements were made of various dimensions considered useful for future maintenance procedures. It was surprising to find that the regions around each gimbal bearing were not clean. Considerable debris, including ferromagnetic particles, was removed after exposing the bearings themselves. Photographs illustrating details of the various critical features within the gyro were made. Sketches were also made in several cases to better show dimensions. Details on the rotor will be sent to certain manufacturers, e.g. Singer-Kearfott, to obtain data on possible replacements. We now have the information necessary for describing procedures for two levels of gyro maintenance, complete disassembly

of the gyro, repair of certain parts, bearing replacement, subtle points concerning bearing and electrical contact adjustments and reassembly of the gyro. The first level of maintenance, which is recommended for depot level repair, involves the cleaning of the gimbal bearings with Freon using a hypodermic syringe and lubrication with a Dow Corning lubricant, such as DC-200. The second level of maintenance, which is not recommended for depot level repair, involves the complete disassembly of the mechanical portion of the gyro and appropriate repair, cleaning, and lubrication procedures. It is suggested that TBE establish a facility for performing second level maintenance on all the gyros.

The gyro drift test which was planned for the end of November at Redstone was cancelled due to the fact that the special vibration equipment in the Inertial Systems Laboratory would not be installed before February 1983.

During the next period, the major effort will be devoted to the preparation of the documentation and the completion of the equipment testing. It is anticipated that the training session will be held as scheduled and that the equipment will be returned to TBE the week of December 20.

Very truly yours,

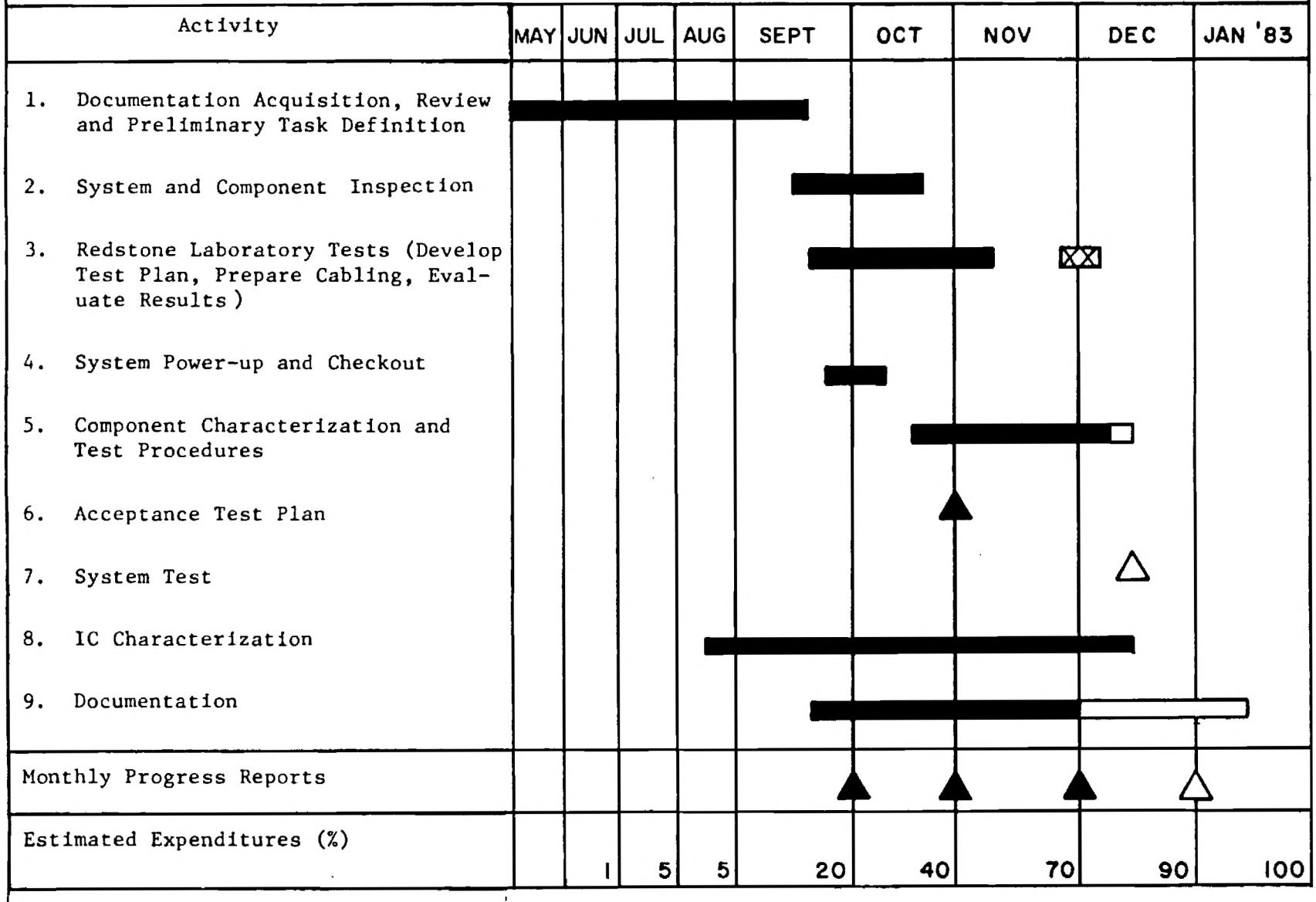
Edwin J. Scheibner
Project Director

EJS:ger

CC:R. Thackray

NOTE: Expenditures through the month of October were $53,054. Figures for November will not be available until the middle of December.

SCHEDULE OF WORK



4-2264

Georgia Institute of Technology
ENGINEERING EXPERIMENT STATION
ATLANTA, GEORGIA 30332

3 January 1983

Teledyne-Brown Engineering Company
Cummings Research Park
300 Sparkman Drive
Huntsville, Al. 35807

Attention: Mr. Roger Watson
Subcontract Technical Monitor

Reference: Subcontract SC-6802
Monthly Status Report No. 4

Dear Mr. Watson:

The designated task under Subcontract SC-6802 is primarily the refurbishment and testing of the Land Navigation Equipment. During the past month major effort was devoted to the documentation of test procedures for the coordinate computer and the disassembly and test procedures for the gyro. The percent completed for each activity in the program is indicated on the attached schedule of work and further details are discussed herein.

On December 6-9, Chuck Semmel of TBE's Systems Engineering Group visited Georgia Tech to review and revise our Acceptance Test Plan. During his visit we were able to demonstrate the operation of the system (i.e., the system test in the schedule of work) and the use of the odometer simulator and the gyro simulator. Realistic error limits were determined for inclusion in the test plan.

All of the special test instrumentation for testing the coordinate computer was completed during the month as well as input and output waveform measurements on each of the PC boards in the computer. With the special instrumentation and the results of the measurements available to TBE's Test Bench Design Group, it should be relatively straightforward to complete the design of a suitable test bench for the computer.

During the next period the major effort will be devoted to the completion of the final documentation. Since it is anticipated that the training session will be held sometime later at TBE, we plan to return the equipment on or about January 14th.

Very truly yours,

Edwin J. Scheibner
Project Director

EJS:ger

CC: R. Thackray

NOTE: Expenditures through the month of November were $83,199.19. Figures for December will not be available until the middle of January.

SCHEDULE OF WORK